CHEMICAL & ENGINEERING NEWS

C&EN

FEBRUARY 10, 1992

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RESEARCHERS PUZZLE OVER SOURCE, ROLE OF ATMOSPHERIC METHANE PAGE 26

FEDERAL R&D FUNDING

Bush proposes 5% rise for 1993 despite otherwise very tight budget Page 7

CHEMICAL & ENGINEERING NEWS

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NEWS OF THE WEEK

- Severe ozone depletion likely will occur over far northern regions within the next decade, and reactions on sulfate aerosol particles are reducing rate of recovery from ozone loss. Page 4

- DNA oligomers used to block thrombin, an important enzyme in blood clotting, may lead to new group of therapeutic drugs. Page 5

- A district court has issued a permanent injunction to stop the Department of Energy from starting tests on an underground nuclear waste repository in New Mexico. Page 5

- New program, called TRANSCAER, is designed to help communities respond to spills and accidents involving transportation of hazardous chemicals. Page 6

COVER: Illustration by John Heinly

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BUSINESS

Taiwan's petrochemical industry is shifting its focus to intermediates, prompting the building of new naphtha crackers and optimization of intermediates mix. Page 17

Trading in pollution rights draws closer to reality with the Chicago Board of Trade becoming the first exchange to propose to operate Environmental Protection Agency's sulfur dioxide emission rights sales program. Page 19

U.S. biotechnology market will grow 16% per year over the next 10 years to more than $14.5 billion by the year 2002, according to market consultants. Page 20

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State Department's low commitment to science and technology is bemoaned in report by Carnegie Commission on Science, Technology & Government. Page 23

SCIENCE/TECHNOLOGY

Conference on atmospheric methane underscores difficulty of defining methane's role in global warming, presents new findings on other atmospheric gases. Page 26

Stable, versatile methyltrioxorhenium catalyst for olefin metathesis, olefin oxidation, and conversion of aldehydes to olefins has been developed in Germany. Page 29

NEWS FOCUS

In the proposed 1993 budget the Administration recently sent to Congress, R&D funding would increase 5%, with individual investigators receiving more support but facilities getting less. Page 7

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LETTERS

Describing hazardous substance

Some months ago you quoted in Newscripts a letter I wrote (C&EN, Sept. 30, 1991, page 84) proposing Conrail for the Euphemism of the Year award for describing butane as a "light, nontoxic hydrocarbon which is commonly used for cigarette lighter fuel." This prompted a letter (C&EN, Dec. 9, 1991, page 2) from Alex Perkins in which he defended Conrail and in which this surprising question appears: "Certainly, the Conrail spokesman could have referred to butane as highly flammable, but does that really serve a purpose?"

It certainly does. For example, on Dec. 23, 1991, a tankcar containing butane derailed and caught fire near Everett, Wash. According to an Associated Press report, the tankcar was still burning two days later, and 100 nearby residents were still evacuated from their homes.

I submit that in the description of a hazardous substance, the most important property should be listed first—not last.

Sidney Toby
Rutgers University
New Brunswick, N.J.

Organic compounds in glass

In David L. Morse's haste to debunk the uniqueness of trapping of organic molecules in porous sol-gel glasses (C&EN, Oct. 28, 1991, page 2), he blundered. Had he practiced his advice to examine the literature before making claims (there are some 150 papers on the sol-gel trapping technique and on its applications), he would have discovered that there is a world of difference between adsorption, impregnation, and surface derivatization on the one hand, and trapping of organic molecules and enzymes in polymerizing metal alkoxides on the other. The literature on the former is voluminous (much beyond Gafney et al. in 1983 and Borelli et al. in 1983, which Morse cites; as well as beyond his unreferenced mention of xerogel uses in the 1960s and of enzyme immobilizations); the latter was, to the best of our knowledge, first described by us in the *Journal of Physical Chemistry* [**88**, 5969 (1984)] and a year earlier in a patent application (Israel patent application 69794, Sept. 23, 1983). Perhaps most notable in that method is the unique combination of true cage-encapsulation, which still allows chemical reactivity with the environment—a development that led to new designs of chemical sensors, of (photo)catalysts, and of bioactive materials (C&EN, May 27, 1991, page 24).

It is true that luminescence of trapped organic molecules in glasses such as boric acid or lead-tin-fluorophosphate is known, yet one should recall that glasses like the ones obtained from boric acid are essentially similar to those obtained by freezing organic solvents, and therefore the comparison to the polymeric network obtained in the sol-gel process is not so straightforward. And we still believe that the present ability to take the thousands of years of history of simple classical silica glasses, and push it a substantial step forward via the sol-gel method, is an important development in modern materials science, with applications that are bound only by imagination.

David Avnir
Chairman, School of Chemistry
Hebrew University of Jerusalem

Cold fusion

Science sociologist Trevor Pinch's review of my book, "Fire from Ice: Searching for the Truth behind the Cold Fusion Furor" (C&EN, Jan. 13, page 28) offers some praise for my account, but evidences the same arrogant misunderstanding of cold fusion research made by my opposite, author Frank Close. Then, lumping both of us together, he fallaciously asserts that both books employ "unrealistic models of science."

Corrections

- Jan. 6, page 42: For the ACS Rubber Division Nashville meeting, four copies of a 200-word abstract must be mailed before May 1 to Julian M. Mitchell, c/o ACS Rubber Division, P.O. Box 499, Akron, Ohio 44309-0499.
- Jan. 13, page 36: The contact for the April 3–4 Two-Year College Chemistry Conference has been changed to O. H. Bezirjian, College of Marin, Kentfield, Calif. 94904.

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Bush's 1993 Budget Proposes 5% Increase in Funding for R&D

NSF's budget would exceed $3 billion, individual investigators would get more support, and various science education plans would receive more funding

David J. Hanson, Bette Hileman, Wil Lepkowski, Janice R. Long, and Pamela S. Zurer,
C&EN Washington

President Bush's budget proposal for fiscal 1993, submitted to Congress on Jan. 30, calls for increased spending on federal R&D activities, but the overall increase he is seeking isn't so large as in his two previous comprehensive budget proposals, primarily because of a scaleback in defense-related research activities.

Under the President's 1993 budget proposal, overall outlays to conduct R&D would be up 5%, or $3.1 billion over current levels, to $72.8 billion. Within that total, outlays for defense R&D, conducted by both the departments of Defense and Energy, would increase 4% to $41.6 billion. However, for civilian R&D outlays would rise 6% to $28.1 billion.

Funding for basic research follows the same pattern as conduct of R&D funding, with outlays for defense basic research slated to rise 8% to $1.3 billion and for civilian basic research 7% to $12.1 billion. The only thing not going up in the overall R&D budget is facilities funding, outlays for which would fall 3% to $3.2 billion.

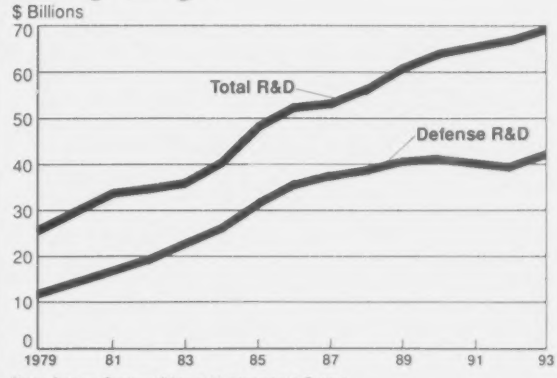
The fiscal 1993 budget proposal contains a number of new, or at least redefined, applied research initiatives. The Federal Coordinating Council for Science, Engineering & Technology (FCCSET), which operates under the auspices of the White House's Office of Science & Technology Policy (OSTP), took a look at two new areas this year. The council performs crosscut analyses of the research programs being carried out by various federal agencies in specific areas of science and technology and then develops coordinated national strategies for meeting long-range goals in those areas.

As a result, there is a new Presidential initiative in advanced materials and processing funded at a level of $1.8 billion, an increase of $162 million over current funding, and another in biotechnology research funded at $4.0 billion, an increase of $271 million. Continuing as Presidential science and technology initiatives under the coordinating council's umbrella are high-performance computing and communications, up $148 million to $803 million; global-change research, up $263 million to $1.4 billion; and mathematics and science education, up $147 million to $2.1 billion.

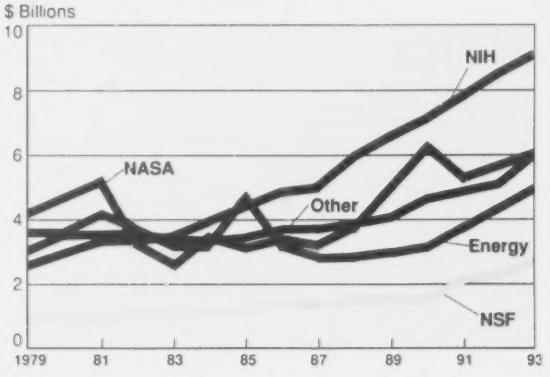
In the following sections, C&EN provides a closer look at the R&D budgets proposed for the various federal agencies that support research activities, starting with the largest R&D funding source.

Defense Department. The most unusual feature of this year's more than 1700-page budget book prepared by OMB that sets forth the facts and figures behind the fiscal 1993 budget is that the military functions of DOD are missing

Defense still accounts for 60% of federal R&D spending . . .



. . . while NIH gets lion's share of nondefense R&D funds



Note: Outlays. **Source:** Office of Management & Budget

from the section that gives the nitty-gritty details on what is going to be spent where. The overall numbers are elsewhere in the book, however, and they show a declining budget for DOD under the President's proposal, mostly from cuts in big-ticket weapons programs and personnel.

A small decrease is also slated for DOD research spending. The fiscal 1993 request for defense research, development, testing, and evaluation programs (RDT&E) is $38.6 billion, 2% below the total fiscal 1992 appropriations. Of this total, according to DOD's own figures, it plans to spend $4.1 billion on basic and applied research, the so-called technology-base programs that are not tied to any specific weapons. This represents a 3% decrease from current-year spending, which is about even with fiscal 1991 spending.

This is the first time in recent memory that an Administration has requested such a decrease in technology-base research, and Congress is expected to come through with a bit more money. Under this category, DOD supports efforts in mathematics, chemistry, meteorology, biochemistry, and solid-state physics.

Under the much larger umbrella of development research programs, Defense plans to spend $34.4 billion. This category includes funding to bring advanced weapons systems to the production stage and to improve existing systems. Special emphasis will be on technology development efforts and the fabrication of prototype systems during the next year. The Administration has requested a large increase for the Strategic Defense Initiative (SDI), up to $5.4 billion from

Outlays for R&D are up 5% . . .

$ Millions	Budget authority					Outlays				
	1993 proposed[a]	1992 enacted[a]	1989 actual	% change 1992–93	% difference 1989–93	1993 proposed[a]	1992 enacted[a]	1989 actual	% change 1992–93	% difference 1989–93
BY AGENCY										
DOD	$40,509	$40,043	$38,031	1%	6%	$38,847	$37,175	$37,545	4%	3%
Health & Human Services	10,649	10,216	7,894	4	36	10,199	9,468	7,486	8	36
NASA	8,673	7,706	5,303	13	64	7,710	7,272	4,975	6	55
Energy	6,578	6,514	5,362	1	23	6,219	6,195	5,692	0	9
NSF	2,375	1,967	1,671	21	42	2,056	1,840	1,557	12	32
Agriculture	1,332	1,328	1,050	0	27	1,285	1,245	1,021	3	26
Commerce	614	580	417	6	47	582	542	363	7	60
Interior	552	583	467	−5	18	546	580	478	−6	14
EPA	525	496	389	6	35	495	454	345	9	43
Transportation	498	446	313	12	59	457	410	322	11	42
Other agencies	1,320	1,214	1,015	9	30	1,264	1,200	1,098	5	15
BY FUNCTION										
Conduct of R&D	**73,623**	**71,093**	**61,913**	**4**	**19**	**69,658**	**66,381**	**60,881**	**5**	**14**
Applied R&D	**59,301**	**57,839**	**51,298**	**3**	**16**	**56,253**	**53,890**	**50,626**	**4**	**11**
Defense[b]	41,988	41,582	39,678	1	6	40,295	38,758	39,596	4	2
Civilian	17,313	16,257	11,620	6	49	15,958	15,132	11,030	5	45
Basic research	**14,322**	**13,254**	**10,615**	**8**	**35**	**13,405**	**12,491**	**10,255**	**7**	**31**
Civilian	13,086	12,053	9,650	9	36	12,142	11,325	9,312	7	30
Defense[b]	1,236	1,201	965	3	28	1,263	1,166	943	8	34
R&D Facilities	**2,933**	**3,498**	**2,293**	**−16**	**28**	**3,189**	**3,286**	**2,054**	**−3**	**0**
TOTAL	**$76,556**	**$74,591**	**$64,206**	**3%**	**19%**	**$72,847**	**$69,667**	**$62,935**	**5%**	**16%**

. . . while those for basic research are up 7%

$ Millions	Budget authority					Outlays				
	1993 proposed[a]	1992 enacted[a]	1989 actual	% change 1992–93	% difference 1989–93	1993 proposed[a]	1992 enacted[a]	1989 actual	% change 1992–93	% difference 1989–93
Health & Human Services	**$ 5,800**	**$ 5,459**	**$ 4,413**	**6%**	**31%**	**$ 5,541**	**$ 5,143**	**$ 4,234**	**8%**	**31%**
NIH	5,328	5,019	4,052	6	31	5,109	4,748	3,988	8	28
NSF	**2,221**	**1,839**	**1,563**	**21**	**42**	**1,917**	**1,730**	**1,455**	**11**	**32**
NASA	**2,068**	**1,860**	**1,385**	**11**	**49**	**1,851**	**1,715**	**1,346**	**8**	**38**
Energy	**1,859**	**1,789**	**1,383**	**4**	**34**	**1,771**	**1,695**	**1,377**	**4**	**29**
DOD	**1,203**	**1,170**	**951**	**3**	**26**	**1,230**	**1,134**	**929**	**8**	**32**
Agriculture	**639**	**611**	**486**	**5**	**31**	**589**	**576**	**477**	**2**	**23**
Other agencies	**532**	**526**	**434**	**1**	**23**	**505**	**498**	**438**	**1**	**16**
TOTAL	**$14,322**	**$13,254**	**$10,615**	**8%**	**35%**	**$13,404**	**$12,491**	**$10,256**	**7%**	**31%**

a Estimate. b Includes military related R&D programs of the departments of Defense and Energy. **Source:** Office of Management & Budget

last year's $4.1 billion, and a serious cut for the Defense Advanced Research Projects Agency (DARPA), down 13% to $1.3 billion. These defense agency budgets will not survive in Congress. Every year, SDI is cut back considerably (and this year, perhaps, even to levels below 1992) and the DARPA proposal is increased.

Within the several military branches, the Air Force gets the largest share of RDT&E funds, with $14.5 billion proposed for fiscal 1993. The defense agencies (mostly because of the development budget for SDI) are next with $10 billion, followed by the Navy with an $8.5 billion proposal and the Army with $5.4 billion.

Health & Human Services. The President's budget seeks about $10.6 billion for research at HHS, a 4% increase over fiscal 1992. The bulk of those funds go to the National Institutes of Health, which would garner a 5% increase to $9.4 billion. NIH, the largest single source of biomedical research support in the U.S., supplies about 30% of all federal funds for academic chemistry research.

Congress has long been generous with NIH, routinely voting to give the agency more money than the Administration asks for. In fiscal 1992, for example, Congress appropriated $8.9 billion for NIH, $160 million more than the President requested.

But Congress last year attached some unwelcome strings to its largess. Some $575 million of NIH's 1992 monies cannot be spent until Sept. 30, the last day of this fiscal year. The Administration had proposed some such "delayed obligations," which push the actual payments from the Treasury into 1993, but Congress increased the amount.

That accounting trick makes the overall federal budget look less sick, but could cause a lot of anxiety among researchers who depend on timely receipt of their grant money to keep their labs running smoothly.

The President's request for 1993 again includes delayed obligations, which this time would shove roughly $600 million of expenses into fiscal 1994.

NIH's budget request for fiscal 1993 would support a record number of research project grants—a total of 22,129,

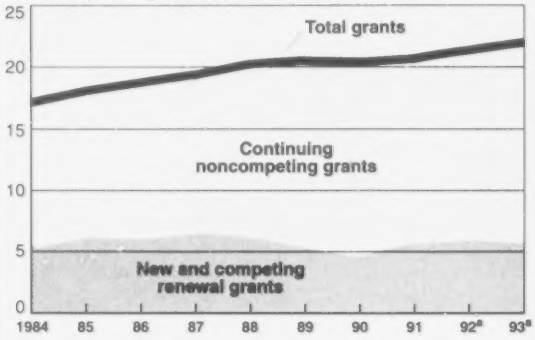
Across the board, NIH units register only modest increases

$ Millions	1993[a]	1992[a]	1991[b]	% change 1991–92
National Institutes	**$8481.7**	**$8101.4**	**$7434.8**	**5%**
Cancer	2010.4	1951.5	1711.6	3
(AIDS)	(175.9	168.8	159.8	4)
Heart, Lung & Blood	1245.4	1191.5	1126.0	5
(AIDS)	(48.2	46.2	46.4	4)
Allergy & Infectious Diseases	1010.8	960.9	907.0	5
(AIDS)	(470.8	449.5	432.0	5)
General Medical Sciences	862.1	815.1	757.9	6
(AIDS)	(17.0	16.1	15.6	6)
Diabetes & Digestive & Kidney Diseases	699.8	662.7	616.0	6
Neurological Disorders & Stroke	615.2	581.9	542.3	6
(AIDS)	(18.6	17.3	16.7	8)
Child Health & Human Development	545.2	519.7	479.0	5
(AIDS)	(38.2	36.1	32.6	6)
Aging	407.3	383.6	323.8	6
Eye	285.1	270.3	253.4	5
Environmental Health Sciences	261.5	252.0	240.6	4
Arthritis & Musculoskeletal & Skin Diseases	214.9	203.9	193.5	5
Dental Research	166.7	159.2	148.7	5
Deafness & Other Communication Disorders	157.3	149.1	135.0	5
National Center for Human Genome Research	**110.4**	**104.9**	**87.4**	**5**
National Center for Research Resources[c]	**330.2**	**314.6**	**335.8**	**5**
Other	**454.8**	**414.7**	**419.1**	**10**
TOTAL	**$9377.1**	**$8935.6**	**$8277.1**	**5%**

Note: Obligations for AIDS research are included in totals for each institute. Subtotals for AIDS are broken out where they exceed $10 million. a Estimate. b Actual. c Previously known as Division of Research Resources. **Source:** National Institutes of Health

Cut in new NIH grants hidden by record awards total

Research project grants awarded, thousands



a Estimate. **Source:** National Institutes of Health

Defense research sags after 1992 jump

$ Millions	1993[a]	1992[a]	1991[b]	% change 1992–93
Tactical programs	$13,242	$14,773	$12,815	−10%
Advanced technology development	7,653	6,421	5,199	19
Intelligence & communications	5,010	5,191	4,474	−3
Strategic programs	4,762	4,727	4,300	1
Technology base	4,084	4,215	3,849	−3
Program management support	3,857	4,097	4,018	−6
TOTAL	$38,608	$39,424	$34,655	−2

Note: Obligations. a Estimate. b Actual. **Source:** Department of Defense, Congressional Research Service

NASA boosts funding for space station, space research

$ Millions	1993[a]	1992[a]	1991[b]	% change 1991–92
Space station	**$2238.9**	**$1986.9**	**$1931.3**	**13%**
Scientific investigations in space	**1775.4**	**1751.6**	**1578.7**	**1**
Physics & astronomy	1110.2	1071.6	971.6	4
Planetary exploration	489.6	532.0	474.9	−8
Life sciences	175.6	148.0	132.2	19
Space applications	**1196.1**	**1065.0**	**795.8**	**12**
Aeronautical research & technology	**884.4**	**767.0**	**505.6**	**15**
Space transportation capability development	**857.1**	**808.8**	**566.2**	**6**
Space research & technology	**361.1**	**313.9**	**297.7**	**15**
Commercial programs	**170.5**	**155.1**	**81.7**	**10**
Transatmospheric vehicle	**77.0**	**20.9**	**95.8**	**268**
Academic programs	**71.2**	**77.4**	**50.5**	**−8**
Safety, reliability & quality assurance	**32.6**	**36.8**	**32.1**	**−11**
Tracking & data systems	**23.1**	**21.4**	**20.0**	**8**
TOTAL	**$7687.4**	**$7004.7**	**$5955.4**	**10%**

Note: Obligations. **a** Estimate. **b** Actual. **Source:** Office of Management & Budget

Funds for global-change research continue strong growth

$ Millions	1993[a]	1992[a]	1991[a]	% change 1992–93
NASA	$ 890.8	$ 755.9	651.6	18%
NSF	162.5	108.5	87.1	50
Energy	113.0	77.0	65.6	47
NOAA[b]	78.2	47.0	47.0	66
USDA	47.6	44.3	38.6	7
Interior	35.8	39.4	36.6	−9
EPA	26.0	24.0	21.8	8
Smithsonian	10.6	6.3	5.4	68
Defense	6.6	6.3	0	5
HHS	1.2	1.0	0	20
TVA[c]	0.1	0.1	0	0
TOTAL	**$1372.4**	**$1109.8**	**$953.7**	**24%**

Note: Budget authority. **a** Estimate. **b** National Oceanic & Atmospheric Administration. **c** Tennessee Valley Authority. **Source:** Office of Science & Technology Policy's Committee on Earth & Environmental Sciences

up from 21,671 projected for fiscal 1992. About three quarters of those, however, are continuing grants. The number of new and competing renewal grants would actually drop about 200 to some 5800 in fiscal 1993.

It was just such a drop in new grants that caused such consternation in 1989 and again in 1990, when the number of new grants awarded declined to fewer than 5000. The more modest drop proposed for 1993 may well renew the research community's fears about inadequate funding.

Perhaps as upsetting to the scientific community, however, is the outlook for training supported by NIH. The proposed 1993 budget would freeze training monies at $309 million—exactly the same level as 1992 and only a few million more than 1991.

"It's going to be a problem," says Marvin Cassman, deputy director of the National Institute for General Medical Sciences (NIGMS). That institute, which is the source of most NIH chemistry funding and which supports a higher proportion of predoctoral students than other NIH units, has been hoping to start a new chemistry-biology fellowship program.

NIGMS's budget would fare slightly better than NIH's as a whole, increasing 6% to $862 million in fiscal 1993. Within NIGMS, the pharmacological sciences program would increase 7% to $130 million; cellular and molecular bases of disease 7% to $239 million; and biophysics and physiological sciences 8% to $177 million.

After several years of huge percentage increases, the National Center for Human Genome Research at NIH would get only a 5% increase to $110 million in fiscal 1993. The project to map and sequence human chromosomes also receives funds from the Department of Energy.

Funds for the human genome project are included in the new Biotechnology Research Initiative that OSTP is introducing for fiscal 1993. The President's budget overall proposes $4 billion for biotechnology research programs in 15 agencies.

R&D addressing AIDS would increase 4% at NIH to $873 million. Those funds would be spread across the various institutes, although the National Institute for Allergy & Infectious Diseases commands more than half. Another $1.2 billion for AIDS research, treatment, and prevention is requested for other parts of the Public Health Service, including the Centers for Disease Control, the Food & Drug Administration, and the Alcohol, Drug Abuse & Mental Health Administration.

National Aeronautics & Space Administration. According to NASA Administrator Richard H. Truly, the fiscal 1993 budget required NASA to "make tough choices because of the constraints placed on our rate of growth for this year." That's not too evident in its fiscal 1993 R&D budget request, which proposes a 10% hike to $7.7 billion. If that goes through, R&D will make up 54% of NASA's total budget of $14.3 billion.

Once again, close to one third of NASA's R&D funds would go to the controversial space station, funding for which would increase 13% over fiscal 1992. Last year the space station was redesigned. In fiscal 1993 the new design will be reviewed and finalized. Also, various critical components of the space station will be fabricated and tested in preparation for a planned launch of some elements of the station in early 1996. Funding is also included for research on a vehicle to return the crew to Earth from the orbiting space station.

Funds for scientific research in space would receive only a 1% boost in fiscal 1993 to $1.8 billion. This consists of research in physics, astronomy, life sciences, and planetary exploration. Funds for building two low-cost robotic systems to map the terrain and resources of the Moon are requested.

Despite President Bush's announced initiative to make U.S. students world leaders in mathematics and science achievement by 2000, the requested funds for academic programs funded by NASA would decline 8% from fiscal 1992 to $71 million.

Glossary of budget terms

Budget authority. The authority provided by federal law enacted by Congress to incur financial obligations that will result in outlays.

Fiscal year. The fiscal year is the government's accounting period. It begins on Oct. 1 and ends on Sept. 30, and is designated by the calendar year in which it ends.

Obligations. Binding agreements that will result in outlays, immediately or in the future. Budgetary resources must be available before obligations can be incurred legally.

Outlays. Payments for obligations incurred under Congressionally granted budget authority generally made by issuance of checks on the Treasury. Outlays during any fiscal year may be made for obligations incurred in prior fiscal years or in the same fiscal year.

Note: The R&D numbers supplied by individual agencies frequently differ from those used by the Office of Management & Budget in preparing its analysis of total federal R&D funding.

SSC receives largest chunk of energy R&D funds

$ Millions	1993[a]	1992[a]	1991[b]	% change 1993–92
ENERGY R&D	**$5638.3**	**$5289.6**	**$4573.6**	**7%**
General science & research	**1644.4**	**1467.3**	**1158.1**	**12**
Superconducting Super Collider	650.0	484.4	265.0	34
High-energy physics	630.9	628.2	582.7	0
Nuclear physics	363.5	354.7	310.4	2
Supporting research & technical analysis	**884.1**	**854.5**	**756.1**	**3**
Environmental restoration & waste management	**707.0**	**610.5**	**432.4**	**16**
Clean-coal technology	**500.9**	**415.0**	**386.4**	**21**
Biological, environmental	**384.7**	**353.3**	**386.5**	**9**
Fusion	**359.7**	**337.7**	**283.6**	**7**
Conservation	**329.8**	**271.2**	**220.2**	**22**
Fossil	**311.3**	**444.3**	**454.8**	**–30**
Nuclear	**309.6**	**332.1**	**299.1**	**–7**
Solar	**206.8**	**203.7**	**196.4**	**2**
DEFENSE R&D	**1414.2**	**1466.3**	**1215.8**	**–4**
TOTAL	**$7052.5**	**$6755.9**	**$5789.4**	**4%**

Note: Obligations **a** Estimate **b** Actual **Sources:** Department of Energy, Office of Management & Budget

NASA's Mission to Planet Earth would receive a boost of 12% to $1.2 billion. The largest fraction of these funds, $308 million, is targeted for the Earth Observing System, six huge satellites to be launched on a variety of expendable launch vehicles that would monitor many processes on Earth simultaneously. Funds for the Earth Observing System would increase 64% from the $188 million in fiscal 1992.

Several Earth probes are also funded under the Earth mission budget. One is a total ozone mapping spectrometer and another is a probe to map tropical rainfall. Funds to replace an aging Landsat satellite are also proposed.

The Earth Observing System and the Earth probe satellites are part of NASA's contribution to the U.S. global-change research program, an interagency effort coordinated by OSTP's Committee on Earth & Environmental Sciences. The Administration is requesting almost $1.4 billion, up 24% from 1992, for research projects aimed at better understanding global environmental issues such as climate warming and ozone depletion.

Those funds are spread over 11 agencies, some with only very small programs. As it has since the coordinated program was initiated in 1989, NASA would claim more than half of the funds—$891 million, up 18% from fiscal 1992. But the President also requested hefty increases for global-change research at several other agencies taking part: a 50% increase to $163 million for NSF, a 47% rise to $113 million for DOE, and a 66% increase to $78.2 million for the National Oceanic & Atmospheric Administration.

Department of Energy. Research funding for the Department of Energy is slated to rise 4% to $7.0 billion in an overall agency budget that would rise only 2% to $19.4 billion. Research thus would account for 36% of DOE's total budget. Funding for DOE's energy supply R&D activities would be up 7% to $5.6 billion, while that for nuclear defense R&D activities would fall 4% to $1.4 billion.

As it did last year, DOE's proposed energy R&D budget benefits from an emphasis on research aimed at advancing the Administration's National Energy Strategy, which has yet to be endorsed by Congress. The President proposes $914 million, an increase of 18% or $140 million, for R&D initiatives for that strategy. DOE's share of the funding would rise 16%, or $99 million, to $725 million.

DOE's research budget also would benefit somewhat from three other of this year's five Presidential science and technology initiatives. It would get 37%, or $678 million, of the amount budgeted for advanced materials processing, an increase of $75 million; 14%, or $109 million, of what's budgeted for high-performance computing, an increase of $17 million; and 3%, or $107 million, of the amount budgeted for biotechnology, an increase of $27 million. Of biotechnology funding, $64.7 million would support DOE's work on the human genome project. Funding for DOE's math and science education activities wouldn't decline in fiscal 1993, as NASA's would, but it would be up just 2% to $114 million.

The budget proposal sets funding for DOE's basic energy sciences program at $644 million, up 12% from 1992. Within that category, funding for chemical sciences is up 11% to $175 million, with research funding up 13% to $115 million, and facilities operations up 6% to $60.3 million. The chemical sciences budget includes $16.8 million for support of biotechnology activities, $3.1 million for materials research, and $900,000 for math and science education.

Funding for materials sciences would rise 13% to $290 million. Of that, research funding would increase 6% to $169 million, and facilities operations funding would rise 24% to $121 million. Funding for DOE laboratories accounts for about 45% of materials sciences research funding, and universities account for about 15%. The materials sciences

budget request includes $2.2 million, a 16% increase, for biotechnology research activities.

National Science Foundation. With a budget rise of 18%, NSF has every reason to feel jubilant about its treatment by the Bush Administration. A commitment was made in the mid-1980s to double NSF's budget over a five-year period, and that effort continues at a pace that would be completed in fiscal 1994, if Congress would just go along with the idea. However, it hasn't shown any sign of doing that so far.

If NSF's request does hold up in Congress, though, the agency would for the first time crack the $3 billion mark. The interesting feature of NSF's budget is that just about all of the increase is accounted for by various initiatives organized under FCCSET—global change, high-performance computing and communications, biotechnology, and advanced materials and processing.

The only initiative that would not receive any significant increase in funding at NSF is mathematics and science education, which would rise only about 3%, from $465 million to $479 million. But as NSF director Walter E. Massey points out, the fiscal 1993 figure "is more than double the level of just two years ago." Massey says a "revolutionary" fruit of that activity has been the statewide systemic initiatives for reform of precollege math and science. And he says a leveling out now will give NSF the chance to "look at ways of better coordinating the funding for all our education and human resources programs."

Indications are that Congress won't mind a little breather in growth for that NSF program. "From our perspective," says one House committee staffer, "we want to see the program consolidated, so we have no trouble with an off-funding year."

Highlights of NSF's fiscal 1993 budget allocations also include:

- $2.21 billion, an 18% increase, in research and related activities, which NSF says will mean that more individual investigators and small groups will see increased funding availability. The chemistry division would get $126 million, up almost $14 million.
- $319 million for advanced materials and processing, a 20% increase. Chemistry's portion of the increase is $5 million, off a 1992 base of $13 million.
- $280 million for environmental and global-change research, a rise of 30%. Chemistry's portion is $2.9 million, added to a 1992 base of $4.3 million.
- $262 million for high-performance computing and communications, up 30%.

NSF's budget is up 18% overall . . .

$ Millions	1993[a]	1992[a]	1991[b]	% change 1992–93
Mathematical & physical sciences	$ 726.0	$ 623.1	$ 564.1	17%
Education & human resources	479.5	465.0	321.9	3
Geosciences	472.4	404.4	367.7	17
Biological sciences	320.6	274.3	255.1	17
Engineering	312.5	258.5	237.7	21
Computer & information science & engineering	272.2	210.9	189.5	29
Antarctic program	163.0	88.4	175.1	84
Salaries & expenses	135.0	109.1	100.9	24
Social, behavioral, & economic sciences	107.8	85.9	79.2	25
Academic research facilities & instrumentation	33.0	33.0	39.0[c]	0
Inspector General	4.0	3.9	2.9	3
TOTAL	**$3026.0**	**$2557.0**	**$2333.1**	**18%**

. . . with funding for the sciences up 14% . . .

$ Millions	1993[a]	1992[a]	1991[b]	% change 1992–93
Ocean sciences	$ 206.4	178.8	$ 164.6	15%
Materials research	167.5	143.6	134.1	17
Atmospheric sciences	151.9	127.2	116.6	19
Physics	148.6	138.4	130.0	7
Chemistry	126.0	112.3	104.7	12
Astronomical sciences	120.0	112.3	100.0	7
Molecular & cellular biosciences	95.5	82.9	76.7	15
Integrative biology & neurosciences	88.5	77.1	72.4	15
Earth sciences	88.1	76.2	70.8	16
Environmental biology	86.5	72.7	68.3	19
Mathematical sciences	85.0	78.6	73.1	8
Social, economic sciences	49.1	40.5	35.9	21
Behavioral, cognitive sciences	24.9	22.2	20.7	12
TOTAL	**$1438.0**	**$1262.8**	**$1167.9**	**14%**

. . . and that for chemical programs up 15%

$ Millions	1993[a]	1992[a]	1991[b]	% change 1992–93
Materials research	**$167.5**	**$143.6**	**$134.2**	**17%**
Project support	96.4	77.4	69.2	25
Laboratories, groups	51.4	48.0	47.2	7
Facilities, instrumentation	19.7	18.2	17.8	8
Chemistry	**126.0**	**112.3**	**104.7**	**12**
Physical	35.2	32.5	30.6	18
Organic & macromolecular	29.9	27.0	25.9	11
Inorganic, bioinorganic, & organometallic	20.6	18.3	17.6	13
Special projects	18.5	14.0	8.8	32
Analytical & surface	15.7	14.4	13.7	9
Instrumentation	6.1	6.1	8.1	0
Chemical & thermal systems engineering	**43.7**	**36.5**	**33.0**	**20%**
Interfacial, transport, & separations processes	11.4	9.4	8.7	21
Fluid, particulate, & hydraulic systems	11.4	10.2	9.3	12
Chemical reaction processes	10.9	8.4	7.3	30
Thermal systems	10.0	8.5	7.7	18
Biochemistry & molecular structure & function	**38.0**	**33.5**	**31.3**	**13%**
TOTAL	**$375.2**	**$325.9**	**$303.2**	**15%**

Note: Obligations. **a** Estimate. **b** Actual. **c** Funds for facilities only. **Source:** National Science Foundation

Of that, only $700,000 goes to the chemistry division. But as chemistry division director Kenneth G. Hancock says, the division is already spending $10 million to support computational chemistry work.

- $206 million for biotechnology research, a rise of 18%. The chemistry division's slice is $3.3 million, added to an already existing base of $10 million.
- $153 million for NSF's various centers, a 9% rise. Two new centers are planned in the fields of manufacturing and materials processing.
- $146 million for undergraduate programs, a rise of 16%. Chemistry's portion is $3 million.
- $105 million for advanced intelligent manufacturing, an increase of 31%. What is being sought here, according to Massey, is "the total integration of design, manufacturing, and business management practices that can lead to developing prototype products and processes quickly." Chemistry has no involvement in this program, although projects to support environmentally benign chemical processing research are in the works.
- $33 million for academic research instrumentation and facilities—but no increase over the past year's and thus disappointing to those in university laboratories.

Overall, NSF's chemistry division budget would rise 12% in fiscal 1993. "It's the best budget request for chemistry in five years," notes Hancock.

Cuts sought in USDA research

$ Millions	1993[a]	1992[a]	1991[b]	% change 1992–93
Agricultural Research Service	$ 721.6	$ 718.9	$ 672.0	0%
Cooperative State Research Service	416.0	508.9	454.3	−18
Forest Service Research	173.7	184.1	186.0	−6
TOTAL	**$1311.3**	**$1411.9**	**$1312.3**	**−7%**

Note: Obligations a Estimate b Actual Source: Department of Agriculture

Multimedia research driving EPA R&D

$ Millions	1993[a]	1992[a]	1991[b]	% change 1992–93
Multimedia	$176.6	$153.7	$120.9	15%
Air	129.2	126.7	101.0	2
Superfund	68.9	66.8	83.8	3
Hazardous waste	42.9	47.8	39.9	−10
Water quality	32.6	30.5	28.0	7
Toxic substances	26.8	25.3	25.5	6
Drinking water	21.9	22.1	18.9	−1
Pesticides	15.8	14.5	11.9	9
Management & support	5.3	5.3	5.1	0
Radiation	5.1	3.5	3.9	45
Leaking underground storage tanks	0.8	0.8	0.8	0
TOTAL	**$525.9**	**$497.0**	**$439.7**	**6%**

Note: Obligations a Estimate b Actual Source: Environmental Protection Agency

Equally excited is Henry McGee who heads the chemical engineering division (formally titled chemical and thermal systems) in NSF's engineering directorate. That division's budget would rise 20% to $43.7 million. Initiative work is mainly covered by a $4.3 million increase for advanced materials and processing, plus another $1.2 million in biotechnology.

"This research budget," says NSF director Massey, "highlights our need to make connection to those outside the immediate sphere of scientific research, especially in some of the more strategic areas. We're doing this by emphasizing in our budget ways to develop stronger partnerships in the form of interdisciplinary research efforts, as well as between researchers, educators, government, and industry."

Thus, although the foundation says it is increasing support for individual investigators and small groups (by 17%), the intention is not necessarily to fund more pure research. Rather, it means that individual investigators will stand a better chance of being funded if they relate their proposals to economic and "quality of life" uses by establishing what Massey calls "partnerships" with the industrial community.

Department of Agriculture. The Bush Administration is asking for $1.3 billion for research at USDA in fiscal 1993—about the same as it requested last year but 7% less than Congress actually ended up appropriating.

The Agricultural Research Service, which conducts basic and applied research at federal labs, would get $722 million, about the same as last year. The Forest Service would receive 6% less research support overall, although small increases are proposed for research related to wetlands, forest health monitoring, and recycling.

USDA's Cooperative State Research Service (CSRS) faces a cut of 18% from 1992 levels to $416 million. Each year the Administration takes monies for facilities and special grants out of CSRS's budget. Congress just as regularly puts it back. These earmarked funds, which send money directly to Senators' and Representatives' favorite projects, prove stubbornly difficult to uproot.

Within CSRS, however, the program of competitive grants known as the National Research Initiative would increase 54% to $150 million under the President's request. That program supports the only research grants at USDA that are distributed under a competitive peer-review process. Proposed in a 1989 report by the National Academy of Sciences, the initiative aims to apply advanced research tools to agricultural problems.

Competition for the grants is keen, despite a cap of 14% on overhead costs imposed a few years ago by Congress. "We are turning down more good science than we can fund," says the initiative's chief scientist, Arthur Kellman. "It's heartbreaking to see how much good research is not being funded."

Environmental Protection Agency. Delving into environmental issues that affect more than one medium has not been a hallmark of EPA research in the past. However, the agency has become increasingly aware of the difficulty in pigeonholing much research into specific environmental media. Thus, multimedia research not only is slated for the biggest increase in EPA's fiscal 1993 budget, up 15% over 1992 to nearly $180 million, but also accounts for the largest single chunk of the R&D budget.

Nevertheless most of EPA's research funding is still di-

Materials sciences R&D funds up 30% at NIST

$ Millions	1993[a]	1992[a]	1991[b]	% change 1993–92
Scientific & technical research & services	**$199.0**	**$172.5**	**$167.6**	**15%**
Materials science & engineering	38.0	29.2	25.7	30
Physics	28.1	26.3	25.1	7
Electronics & electrical engineering	28.0	23.7	18.8	18
Research support	**25.0**	**24.2**	**18.5**	**3**
Chemical sciences	20.6	18.7	18.3	10
Computer systems	17.3	11.9	11.6	45
Manufacturing engineering	12.8	9.5	8.7	35
Building & fire research	12.2	11.0	10.8	11
Other	17.0	18.0	30.1	−6
Industrial technology services	**86.1**	**102.7**	**49.1**	**−17**
TOTAL	**$285.1**	**$275.2**	**$216.7**	**4%**

Note: Obligations. **a** Estimate. **b** Actual. **Source:** Office of Management & Budget

NIH claims bulk of biotechnology research funds

$ Millions	1993[a]	1992[a]	1991[b]	% change 1992–93
NIH	**$2943.9**	**$2800.6**	**$2526.3**	**5%**
Energy	242.7	181.9	152.7	33
NSF	206.0	174.0	162.0	18
Agriculture	167.7	179.4	161.6	−6
ADAMHA[c]	111.2	94.0	79.0	18
Veterans Affairs	88.4	85.6	80.6	3
Defense	86.6	81.0	79.6	7
NASA	44.7	36.6	26.5	22
FDA	36.2	34.7	28.8	4
CDC[d]	33.7	33.7	28.6	0
AID[e]	30.7	21.5	19.0	43
EPA	18.3	15.9	14.3	15
Commerce	13.0	13.0	12.7	0
Interior	5.0	5.2	5.9	−4
Justice	2.3	2.2	1.8	5
TOTAL	**$4030.4**	**$3759.3**	**$3379.4**	**7%**

Note: Budget authority. **a** Estimate. **b** Actual. **c** Alcohol, Drug Abuse & Mental Health Administration. **d** Centers for Disease Control. **e** Agency for International Development. **Source:** Office of Science & Technology Policy's Committee on Life Sciences & Health

rected toward meeting legislative mandates or assessing data from existing programs, so-called media-specific research. Of the $526 million requested for research in fiscal 1993, only $172 million, up $12.3 million, is pegged for basic research.

The biggest part of the regulatory research effort will be directed toward implementing the 1990 Clean Air Act Amendments, which will receive $102 million of the total $131 million to be used for research underpinning new regulations. EPA says emphasis will be on monitoring for compliance with new ozone standards in metropolitan areas, air pollution from motor vehicles, and health concerns of air toxics. Another research project will address neurotoxicological effects of pesticide residues on foods.

Other R&D themes stressed by EPA in fiscal 1993 include clusters and international support. The cluster concept is designed to take a multidisciplinary approach to environmental problems, helping to solve complex issues without as much duplication. EPA says it will provide $31.5 million to research cluster projects, with the major effort focused on understanding how to monitor and reduce indoor air pollution problems. Funding for the agency's international research support effort would increase $8.2 million to $58.2 million in fiscal 1993. Primary areas of emphasis will be global climate change, high-performance computing, advanced materials, and biotechnology.

National Institute of Standards & Technology. With a 26% boost in its total budget request, NIST—formerly the National Bureau of Standards—enjoys an even bigger percentage increase than NSF. NIST's budget would increase from $247 million to $311 million with the big emphasis on stimulating the commercialization of new technologies. As NIST's director, John Lyons, puts it, the budget "greatly expands our outreach efforts to industry, improves our capability to acquire and disseminate superior expertise on the latest technologies, and creates a positive environment for research advances that will fuel new product development and economic growth."

NIST's 1993 budget request would provide, among other things:

- $202 million for intramural laboratory research and supporting services, a 13% increase over current funding.
- $67.9 million for the Advanced Technology Program, up 36%.
- $17.8 million for manufacturing technology centers, up 13%.
- $22.7 million for facilities construction.

Under Lyons, NIST has been gingerly moving toward becoming the prime federal center for stimulating industrial innovation in critical technologies such as advanced semiconductor fabrication, biosensors, high-speed digital communications, and new engineering concepts. Some of the other high-priority items within NIST include research in magnetic media, advanced materials, chemical processing techniques, and computer and telecommunications technologies.

In fiscal 1993 NIST plans to support more advisers in U.S. embassies to help break down standards-based trade barriers in foreign countries. And it will boost NIST's capabilities in atomic-scale structures and interactions. NIST's outside work now accounts for about a third of its total budget. In fiscal 1989, that amount was only about 10%.

Any analysis of an Administration budget proposal must conclude with the warning that the Administration proposes, but Congress sets final budgets, as is its duty under the Constitution. The majority of the numbers in the Administration's budget proposal will be revised, either upward or downward, before a final fiscal 1993 budget is in place. If recent history is any indication, funding for most research programs probably will increase slightly. □

Taiwan's Petrochemical Industry Entering New Developmental Phase

■ ***Focus is now on intermediate chemicals and optimization of their mix, prompting construction of new naphtha crackers***

Joseph Haggin, C&EN Chicago

The petrochemical industry in Taiwan is about to enter another developmental phase at the same time that the national economy is shifting emphasis. Jer-Ru Maa, president of National Cheng Kung University, characterizes the shift as being from a capital-intensive to a technology-intensive mode.

A less cryptic characterization, offered by a more candid observer, is that like other "microtigers" in the Far East, such as South Korea or Singapore, Taiwan is faced with the problem of generating its own commodities, and the most salable one at the moment happens to be technology. The advantages of cheap labor that formerly accrued to the microtigers have faded somewhat. Without natural physical resources, the smaller countries are losing the competitive advantage they formerly enjoyed in a world marketplace.

An added problem for Taiwan is its relations with China. But the Kuomintang, Taiwan's major political party, captured 71% of the popular vote in national elections last Dec. 21. The strength of this nationalist party thus obviates any need for further rhetoric concerning "reform, stability, and prosperity" through improved relations with China. More consistent government policies are expected to result, and the chemical industry likely would be a beneficiary.

The key to Taiwan's petrochemical industry is the slate of intermediate chemicals from its refineries. These provide the feedstocks for fibers, plastics, rubbers, and specialty chemicals. They also serve as the indirect source for some pharmaceuticals.

The immediate aim of the petrochemical industry is to increase the added value of the products produced rather than to expand the volume of lower value commodity chemicals. Considering the very close mutual dependence among the various parts of the industry, making the best use of the intermediates is a classic problem in optimization.

In optimizing the intermediate mix, greater attention will be given to control of the molecular weights and purities of the various intermediates, much as a refiner does who wants to control the research octane number of the fuel in the gasoline pool. Molecular weight control is crucial for specialty chemicals manufacture. Process development in the future is to be integrated with selection of intermediates to specifically target terephthalic acid, phenolic derivatives, styrene derivatives, and the C_4/C_5 fractions. Catalysis and process control will become dominant disciplines in the immediate future.

One of the industrial groups targeted for special promotion is the pharmaceutical industry. By the year 2000, this industry is projected to have a production value of about $160 million (based on one Taiwan dollar = $0.0397 on Jan. 16), fueled by a bigger population, a higher living standard, a national health insurance program, and exports.

Included among development centers for pharmaceuticals is Union Chemical Laboratories in the Industrial Park at Hsinchu. The company's principal products include anti-inflammatory drugs (acetaminophen, ibuprofen, naxproxen), antibiotics (PenG and CephC series), and cardiovascular agents (inositol, atenolol) and a new dosage form of these agents. The keys to these and other developments are strong commitments to chiral syntheses, racemic resolution, and new transdermal delivery formulations. The company claims these methods will involve a new generation of biosynthesis and processes for making generic and bulk pharmaceuticals.

Among the specialty chemicals Union Chemical is focusing on are modifiers for plastics—for example, reactant impact modifiers, polymer antioxidants, and linear alcohol plasticizers. Also in the works are silicon- and fluorine-containing specialty chemicals for textiles. Much attention will be given to controlled release techniques for the delivery of some of these specialty chemicals for long-service applications.

In the area of functional polymers, emphasis will be on polyphenylene sulfide and the

Six naphtha crackers are located throughout Taiwan

polysulfones. Additional emphasis will be on polymeric membranes, biodegradable and biomedical polymers, and the technology for producing them.

Synthetic fibers are also of special interest because so much of Taiwan's chemical business is aimed at synthetic fabrics. The emphasis at Union Chemical is currently on development of ultradenier fibers (especially those with fire-retardant characteristics), hollow fibers, and nonwoven materials. One of the more intriguing developments is the emergence of chromophoric fibers, from which garments are made that change color in response to varying light intensities. Several of these chromophoric fibers are nearly ready for commercialization.

The importance of petrochemical intermediates in the near future has prompted two major developments. First is a modernization of the sources for intermediates, specifically the building of new and the scrapping of old naphtha crackers. Second is optimization of the intermediates mix. Nearly all of the feedstocks for the Taiwan petrochemical industry come from the naphtha crackers that are associated with refineries of Chinese Petroleum Corp. (CPC). Wenent P. Pan, vice president for corporate planning, and Hsin-Hsing Tsai, executive secretary of the R&D advisory committee, both for CPC, note that modernization of the refining facilities is now under way and that some new naphtha crackers are either under construction or in the planning stages.

Soon the first two naphtha crackers to have been built in Taiwan will be scrapped and replaced by new ones. In the process, total capacity from the new crackers will be increased. In all cases, the principal product will be ethylene.

A total of six naphtha crackers are now on the books to be operated by various interests. In addition to these naphtha crackers, a small ethane cracker also is operated by China Petrochemical Development Corp. at Tou-Fen. Cracker No. 5 is under construction near Kaohsiung and No. 6 is still in the design stages. The location has not been specified, but No. 6 is expected to be located between Taipei and Hsinchu, with construction starting probably in 1994. Total production of all six crackers has been projected to be about 1.8 million metric tons per year of ethylene. When No. 1 and 2 crackers are scrapped, production will be reduced by 284,000 metric tons per year.

Optimizing the output of the naphtha crackers is the focus of one new government project aimed at increasing the competitive position of Taiwan's petrochemical industry. According to Johnsee Lee, deputy general director of the Industrial Technology Research Institute (ITRI), his organization has been given the job of doing the optimization. The object is to target the products and processes that would be most suitable for Taiwan. To this end, Chem Systems Inc. of the U.S. has been retained as an independent contractor.

In the first phase of the project, to be completed three months after the start of the job, Chem Systems will identify market potentials, global competition, investment risk, raw materials sources, technology sources, and the strengths and weaknesses of the Taiwan industry. Chem Systems will also recommend target products and processes for further research and development.

In the second phase of the project, more detailed assessments will be made. This phase is expected to be completed within eight months of the start of the project, at which time the government will seek to attract private investment in support of necessary R&D. An advisory group from industry, Union Chemical, and ITRI will assist Chem Systems. The entire project is scheduled to be completed this fall.

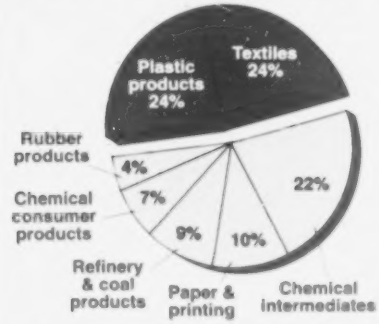
Not all of Taiwan's petrochemical industry is in Taiwan. There are at least nine overseas companies currently operating in the U.S., the Philippines, Singapore, Malaysia, Saudi Arabia, and Canada. All of these operations are based on ethylene and aromatics production.

Some of these overseas operations have had problems. In one case, the Taiwan government has been at odds with Wang Yung-ching, president of Formosa Plastics Corp. and possibly Taiwan's richest man. In 1990, reports suggested that Wang made an unauthorized trip to China to talk about a possible petrochemical project in Fujian Province. To avoid difficulties with Taiwan, Wang moved to the U.S., where his company has several chemical plants in Texas. The future of the Fujian project is in doubt since most of the capital probably would come from the nationalized banks in Taiwan, which would be guided by government policies not favoring China.

Taiwan petrochemical feedstocks come mainly from naphtha crackers

Company location	Cracker No.	Installation date	Ethylene capacity (thousands of metric tons per year)	Type
China Petrochemical Co.				
Kaohsiung	1	1968	54	Naphtha
	2	1975	230	Naphtha
Lin-Yuan	3	1978	230	Naphtha
	4	1984	385	Naphtha
Kaohsiung	5	1993	400	Naphtha
Formosa Plastics Corp.				
(Undecided)	6	—	450	Imported naphtha
China Petrochemical Development Corp.				
Tou-Fen	—	1973	54	Ethane

Plastics, textiles are big part of Taiwan's chemical output



1990 production = $560 million

However, Wang might also raise the capital outside Taiwan.

With expansion and optimization expected for Taiwan's petrochemical industry, considerable catalysis R&D will have to be carried out. Much of this work will be done by the Catalyst Research Center (CRC), a unit of China Technical Consultants Inc. CRC was founded in 1981 as a joint venture of China Petrochemical Development Corp. and China Technical Consultants, mainly to serve as the corporate R&D facility for China Petrochemical Development. In 1984, the center was reorganized and became a formal unit of China Technical Consultants with a 12-year renewable cooperation agreement with China Petrochemical Development. It also serves local industries and conducts contract research from other sources.

Chun-Mann Tsao, deputy director of CRC, says the center currently has about 100 people and a 1991 budget of some $4 million, roughly divided into 30% from in-house research and 70% from contract research. The contract research is performed for CPC, China Petrochemical Development, the government, and elements of the private sector.

A major effort at CRC is devoted to catalyst development with special emphasis on the process. Particular attention is given to polymeric materials synthesis, compounding polymers, analysis connected with process control, and antipollution measures. Among the technological developments now available from CRC is a new catalytic converter for automobiles and motorcycles. This is of particular importance to Taiwan, where there is a plethora of two-stroke cycle motorcycle engines, which are notorious polluters. CRC also offers its own technology for such things as catalytic tailgas cleanup, a molybdate-based ammoxidation catalyst, aniline from phenol, and carbon fiber precursors. The center is now operating in the administration building of an obsolete ethylene plant that is being scrapped in preparation for a new venture. □

Trading in pollution rights nearer reality

The Chicago Board of Trade will be under intense scrutiny in the months ahead, because late last month it became the first exchange to propose to operate the Environmental Protection Agency's sulfur dioxide pollution rights sales program.

An environmental group, the Environmental Defense Fund, first proposed an emissions trading system under the theory that if the number of allowances granted to utilities that emit sulfur dioxide is less than the amount of SO_2 they emitted in recent years, they would be forced to cut emissions or buy more allowances on the market (C&EN, Nov. 18, 1991, page 20). Because EPA will impose a $2000-a-ton penalty on utilities that exceed their allowances, any utility that can cut emissions, or obtain allowances for less than $2000 a ton, has an incentive to do so. An EPA spokesman says that although utilities could acquire more emission allowances than they were originally granted, the utility still could not exceed local government emission limits.

The EPA's program seeks to control acid rain through limiting total coal- and oil-burning electric utility emissions to 8.9 million tons of SO_2 per year by the year 2000 from a current 16 million tons (C&EN, May 27, 1991, page 18). The Chicago Board of Trade figures into the equation as the point of sale, auction, and registry of 2.8% of SO_2 emission allowances available for sale in any one year. Operating utilities automatically receive, at no cost, 97.2% of allowances based on past emissions. The first EPA-sanctioned auction and sale would be in 1993 for allowances first usable in 1995 and thereafter. Any citizen, broker, utility, or group may purchase the emission allowances, each allowance permitting the emission of 1 ton of SO_2. And further, owners may sell the rights to any other citizen, broker, utility, or group.

At least one other exchange, the New York Mercantile Exchange, is "seriously considering" making a proposal to EPA. However, it must do so by EPA's Feb. 21 deadline if it intends to seek authority to operate EPA's pollution rights sale and registry.

Since the passage of the 1990 Clean Air Act, in which Congress authorized the creation of a system of transferrable emission allowances, the South Coast Air Quality Management District in California has said it too plans a free market system to control sources of smog and to lower atmosphere ozone. In addition, the United Nations has issued a report in Geneva that proposes world trading in carbon dioxide emission allowances in an effort to control global warming. One author of the UN report is a director of the Chicago Board of Trade. A spokesman for the board says the exchange also would be interested in running an international carbon dioxide emission allowances market.

Not only is the Chicago Board of Trade the first to publish its plan to operate EPA's annual auction and sale of SO_2 emission rights, but it also has made public two additional proposals that together would constitute a well-organized trading system for emission rights. The board filed a proposal in September with the Commodity Futures Trading Commission, which if approved, would allow the board to operate a market beginning late this year to sell the right to emit SO_2 at a predetermined date in the future. The futures market would allow utilities to purchase future emission allowances as a hedge against higher priced emission allowances in the future. In addition, the board has offered to run a "spot" market that would allow utilities to buy or sell current SO_2 emission rights.

In addition to the enthusiasm the board has shown to trade SO_2 emission allowances, and the New York Mercantile's statement of interest, the American Stock Exchange has indicated it would like to get into the act. An American Stock Exchange spokesman says it might set up a market to trade SO_2 emission options. Trading in options allows the buyer the right to buy or sell a commodity such as an SO_2 emission allowance at a specified price during a specified contract period. Trading in options would be another hedge for utilities, allowing them to secure emission allowances for a nominal fee without having to buy the emission allowances outright.

Electric utilities and even the Chemical Manufacturers Association are generally sanguine about the emission rights approach to limiting SO_2 emissions. A spokesman for Edison Electric Institute, a Washington, D.C.-based association of investor-owned utilities, says that electric utilities are committed to making the trading system work.

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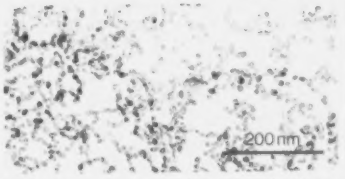

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good film forming
good binding
and other unique properties.

for Binder?
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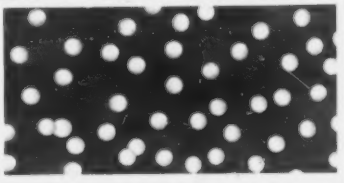
or?



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"We like the whole concept." The association is a little more tentative about prospects for limiting carbon dioxide emissions under UN auspices, or even for the proposals to utilize market forces to limit emissions in Southern California: "It's a very new idea. We need to have the bugs worked out."

CMA "in general" likes emission trading proposals, too, because they offer "an efficient way to allocate resources," says Richard G. Sigman, air program associate director.

Not all environmental groups, however, agree that market forces are the best approach to limiting emissions. David Hawkins, a senior attorney for the Natural Resources Defense Council in Washington, D.C., "supports" the basic emission allowance trading program to limit acid rain, and believes that it "can be environmentally sound." Where SO_2 is concerned, "the sources are knowable and can be accurately measured," he says. That, however, is not the case with many other air pollutants, he adds, because they are numerous and difficult to quantify.

But Hawkins cautions that the only way in which the market approach can work is if EPA makes sure that a utility's emission allowances are carefully accounted for, and actual utility emissions are accurately measured. The Southern California proposals depend on a lot of engineering guesses about actual emissions of a large variety of air pollutants, he says. Under that scenario, trading in emission allowances "would be like measuring deposits and withdrawals to the nearest $10. Anyone could quickly learn to drain the bank dry."

Paul Bjorn, of the accounting and consulting firm Price Waterhouse, notes that the success of SO_2 emission allowance trading programs will depend on what actions states and public utility commissions take in regard to utilities operating under their jurisdiction. Bjorn, who is chairman of Price Waterhouse's public utility industry service group in Cleveland, says that some high-growth states, such as Florida, may require utilities to sell emission allowances only to other in-state utilities.

Ultimately, the success of any market system to limit hazardous emissions will depend on the cooperation of both federal and state regulators and on the regulated. An EPA spokesman says the federal government cannot tell state regulators how to regulate their jurisdiction. But he says that in regard to SO_2 emission allowances, EPA is encouraging local regulators not to restrict utility participation in a national trading market.

Marc Reisch

Huge growth forecast for biotech markets

The U.S. market for biotechnology products will reach nearly $3.5 billion this year, according to a report by Consulting Resources, a Lexington, Mass.-based market consulting firm. Over the next decade, various segments of this market will grow tremendously, resulting in an overall average growth rate of about 16% per year for the industry. By the start of the new decade, the market is expected to amount to more than $14.5 billion.

The biggest market segment is human therapeutic products, forecast to reach $2.25 billion in sales in 1992. Whereas sales currently are based only on just over a dozen products, most of which have been approved by the Food & Drug Administration in the past seven years, there are more than 20 awaiting review at FDA and at least another 135 in clinical trials. This market will continue to be the largest, hitting more than $9 billion by the year 2002.

Currently, products developed and marketed by biotechnology companies

U.S. biotech sales to increase about 16% per year

$ Millions	1992	1997	2002	% average annual change
Therapeutics	2250	4800	9,200	15%
Diagnostics	1050	1700	2,500	9
Agriculture	70	375	1,400	35
Specialties	95	400	1,300	30
Other[a]	10	100	250	38
TOTAL	3475	7375	14,650	16%

a Includes nonmedical diagnostics. Source: Consulting Resources Corp.

or sold by their larger pharmaceutical company partners include erythropoietin and granulocyte colony-stimulating factor, with combined sales of $645 million in 1991 for Amgen. Similarly, Genentech's 1991 product sales, which include tissue plasminogen activator, human growth hormone, and γ-interferon, are estimated to be about $400 million. Granulocyte-macrophage colony-stimulating factor, Immunex's first product approved for marketing in 1991, may have had sales of nearly $40 million for 1991. Biogen, Chiron, and Genentech also receive royalty income on sales of products such as α-interferon, human insulin, and hepatitis B vaccines, which have product sales of many hundred million dollars.

Diagnostics, among the first biotechnology products to be developed and to bring in revenues for many young companies, are now viewed as a more mature part of the industry. Growth in sales of diagnostics at about 9% annually over the next 10 years is expected to be below the industry average. Even at this growth rate, the market will more than double by 2002, increasing from about $1 billion in 1992 to $2.5 billion in 2002.

Growth rates will be larger for those markets starting from much smaller base levels. Agricultural biotechnology, which has lagged other areas in delivering new products, is poised for a growth rate of 35% per year. Consulting Resources still sees what it calls "limited progress," with sales rising from about $70 million in 1992 to over $1 billion by the end of the century. Growth will depend largely on more products, such as biopesticides and genetically engineered crops, receiving Environmental Protection Agency approval and making inroads into agricultural markets. Although many naturally occurring biopesticides now are marketed by several companies, only two genetically engineered biopesticides, developed by Mycogen, have passed regulatory hurdles.

Another area that may register as much as 30% growth per year is that of enzymes and specialty or fine chemicals produced by biotechnology. The market is forecast to amount to about $95 million this year and to soar to $1.3 billion in 2002. Similarly, sales of nonmedical diagnostics will record a growth of nearly 40% per year during the next 10 years.

Ann Thayer

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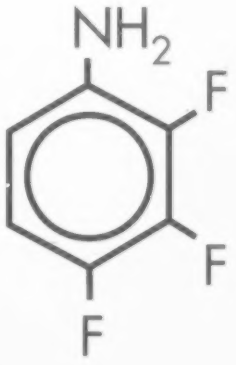

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